Impacts of Observations on NCEP GODAS Analysis

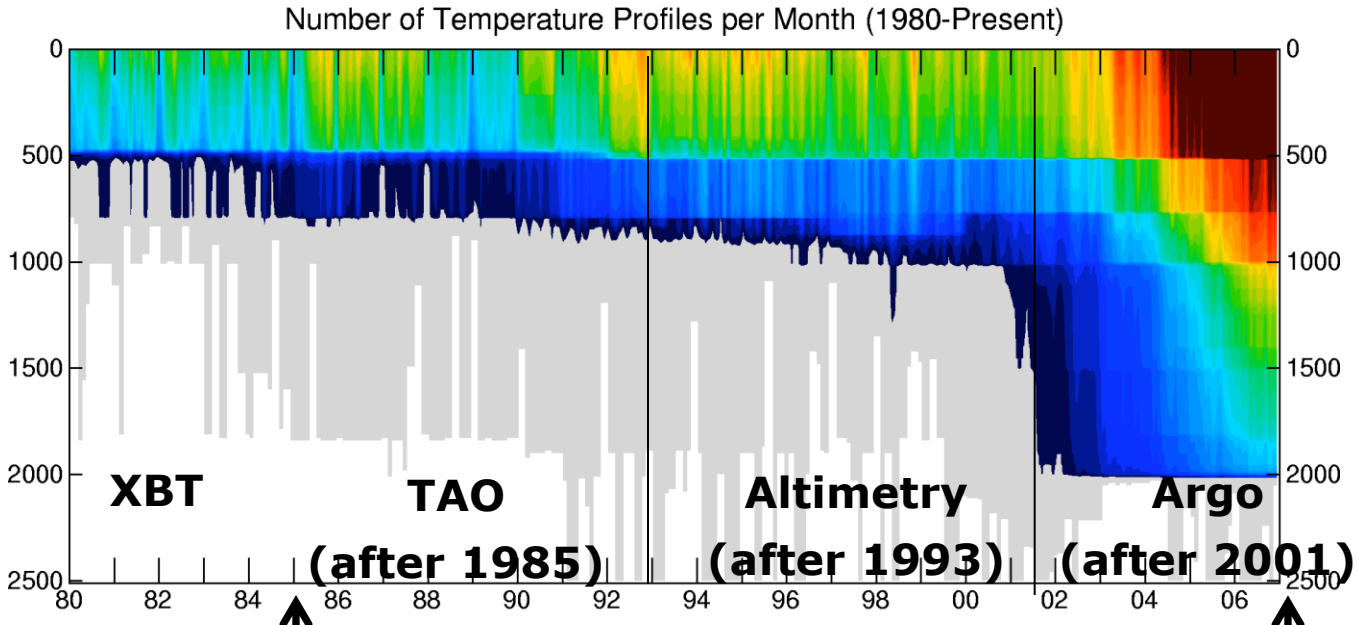
Y. Xue, C. Wen, D. Behringer, A. Kumar

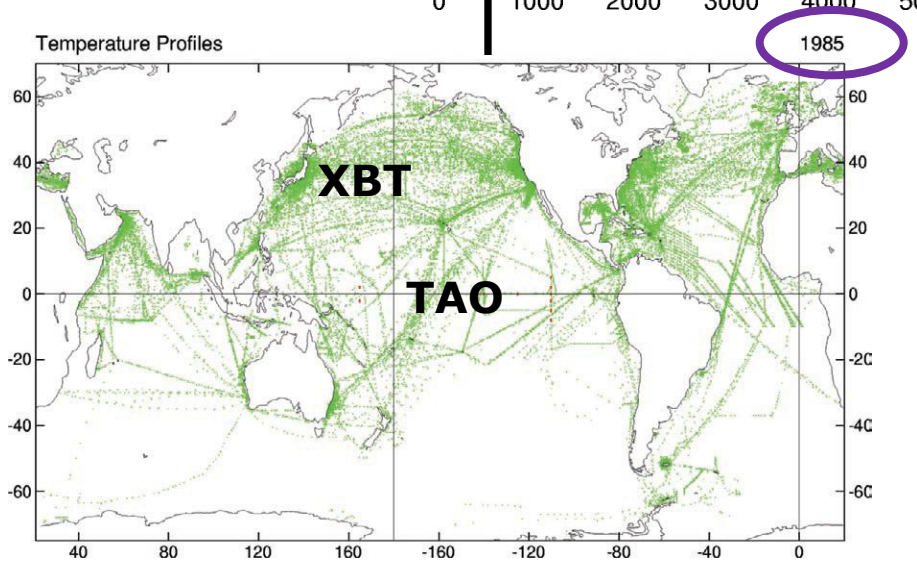
NCEP/NOAA, USA

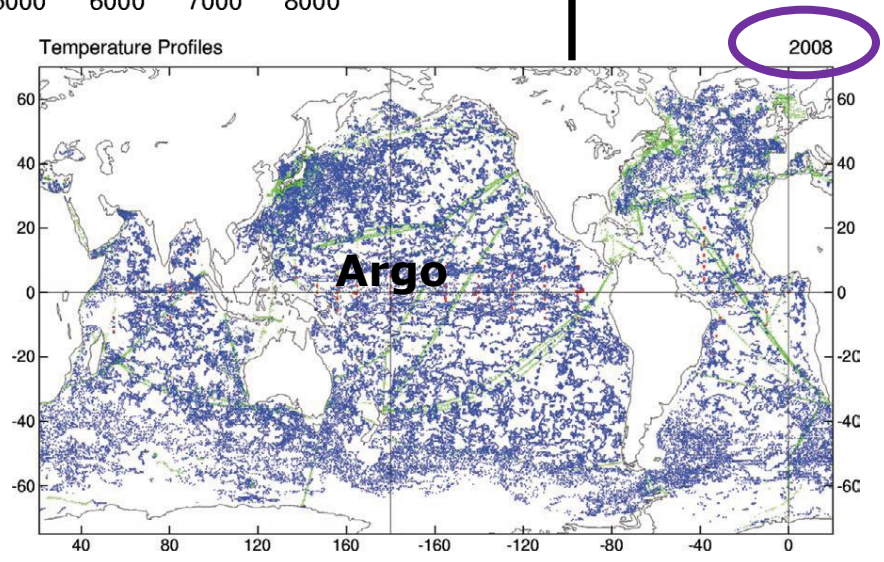
NOAA Climate Reanalysis Task Force Technical Workshop, NCWCP, May 4-5, 2015

Global Ocean Observations

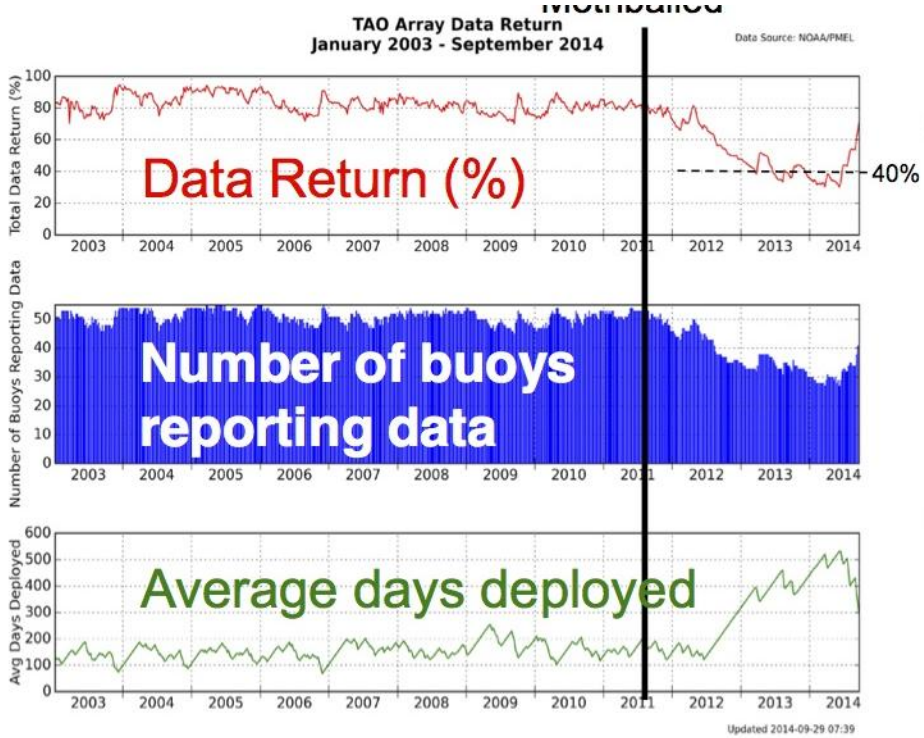
from Saha et al. (2010)



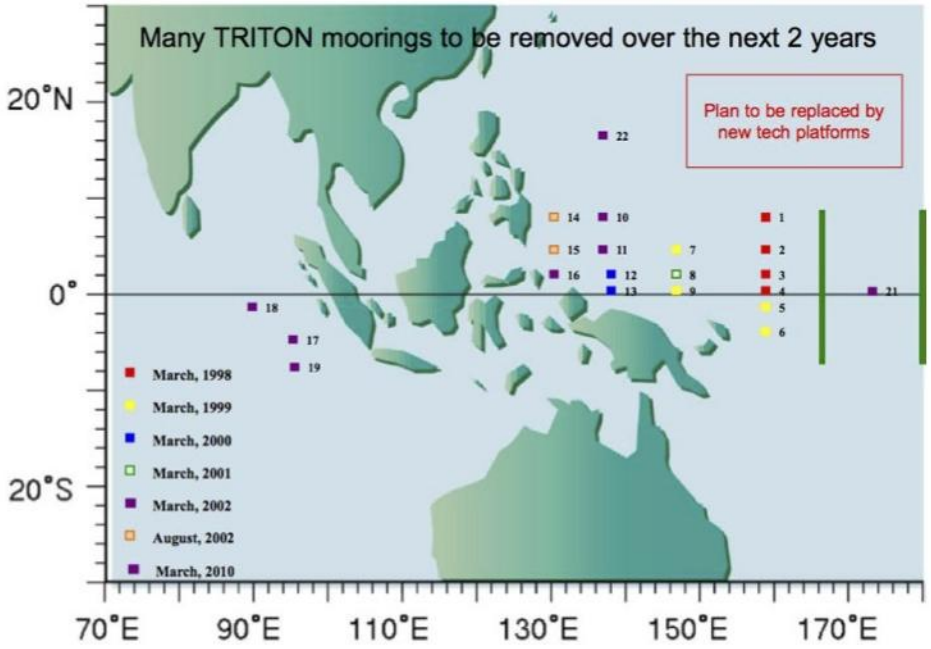




Recent Challenges: TAO-TRITON Mooring Array



McPhaden, PMEL



Ando, JAMSTEC

- TAO data return fell below 40% in early 2014; since returned to 80%, for now.
- Around half of TRITON Moorings will be removed by mid 2015.

Courtesy of Katy Hill

TPOS 2020 Workshop

27-30 January, 2014, Scripps Institution of Oceanography

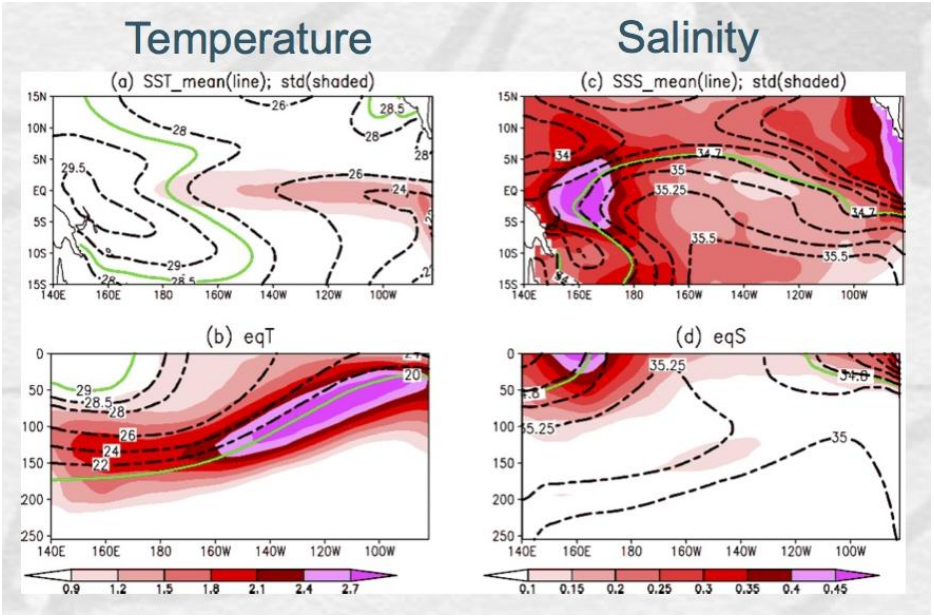
- Review of observing system requirements and implementation
- Presentations on status of all aspects of system
- Presentations on potential new science and contributions
- Sponsors:

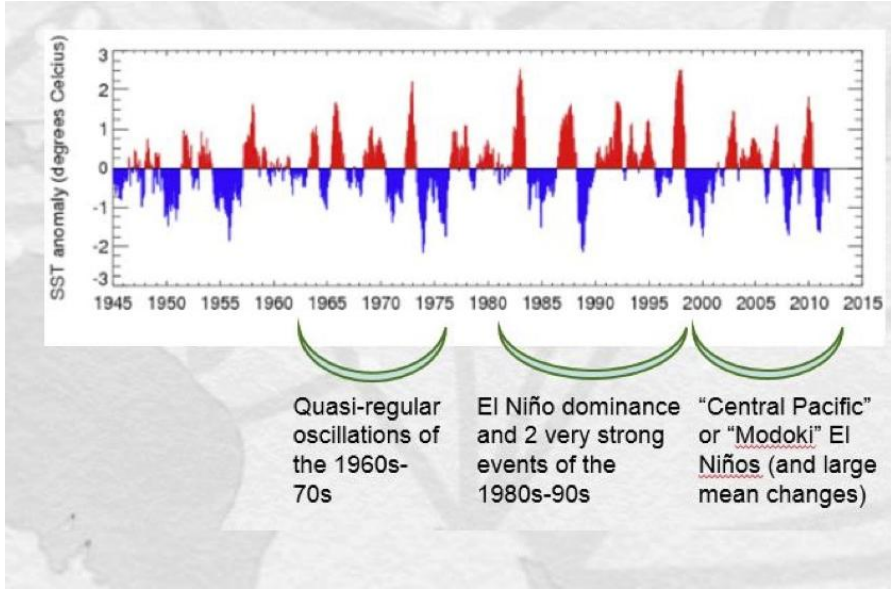
GCOS · The Global Ocean Observing System · GOOS · NOAA · KIOST

- Chaired by: David Anderson and Toshio Suga
- Report: Published April 2014 (www.ioc-goos.org/tpos2020)

TPOS 2020 Tropical Pacific Observing System

- The role of salinity
- Changes in predictability
- Evidence from systematic errors
  - To guide design, process studies, etc.
- Frameworks for sensitivity studies

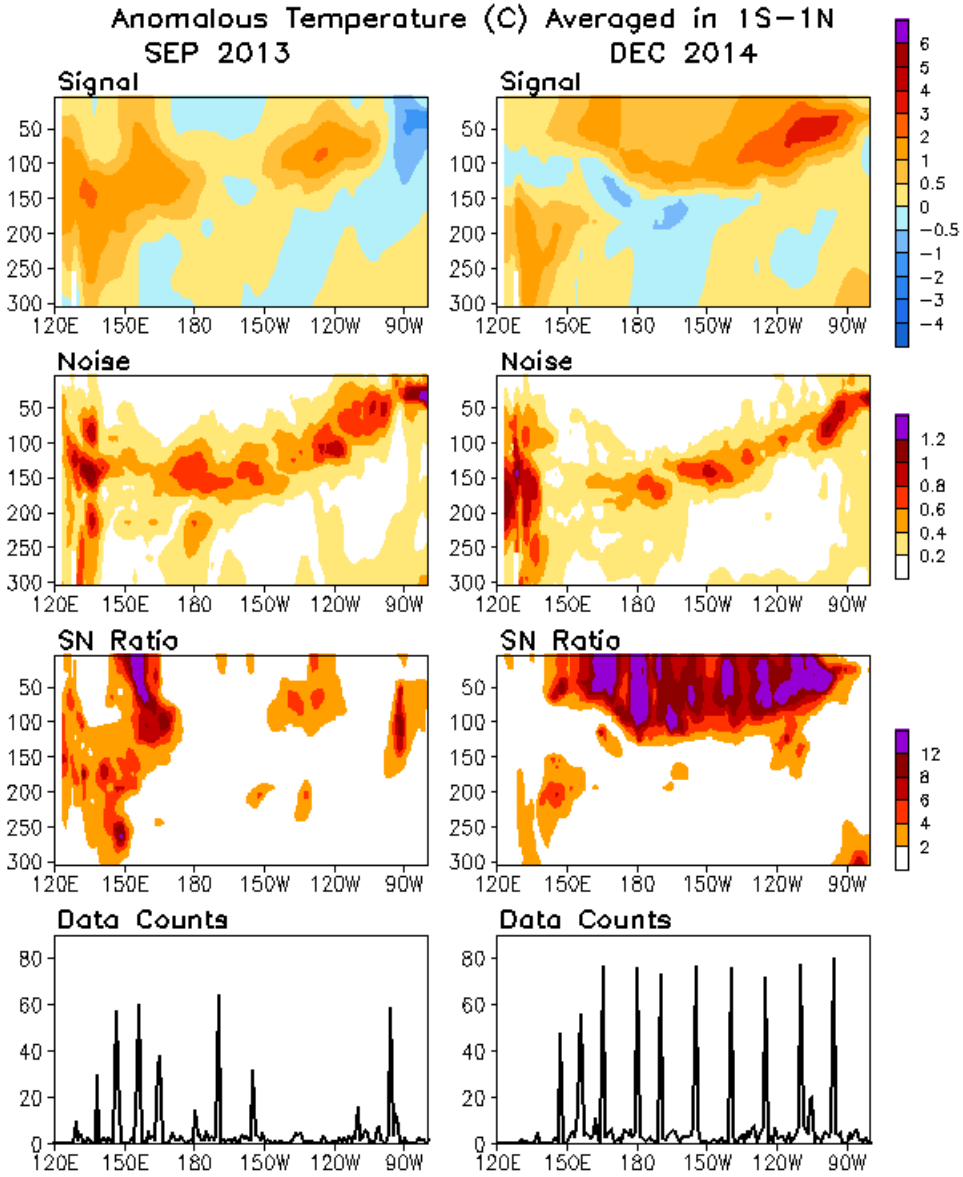




Courtesy of Neville Smith & Billy Kessler

Real-Time Ocean Reanalyses Intercomparison

(http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html)

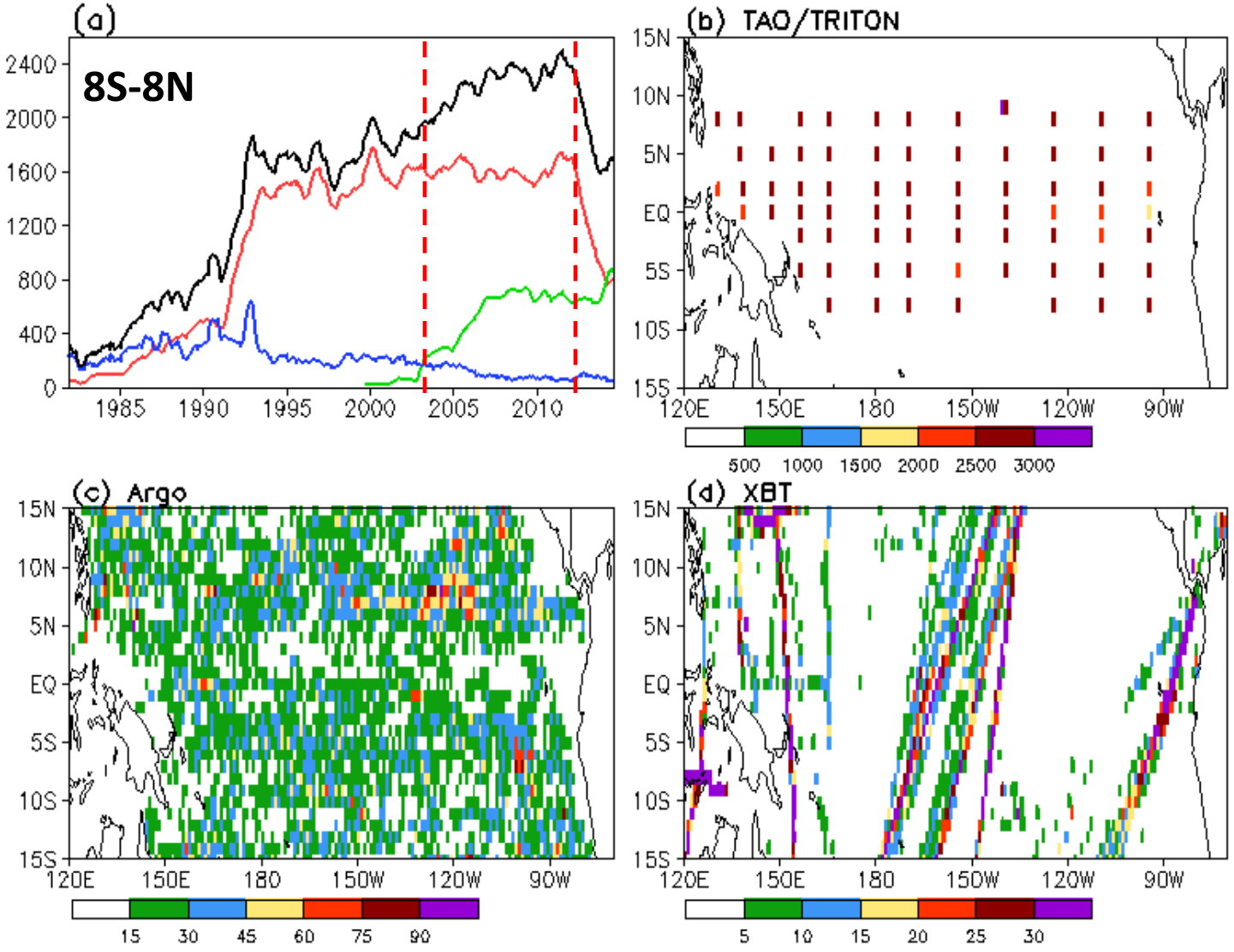


- **Assess uncertainties in tropical Pacific temperature analysis in real time for ENSO monitoring and prediction**
- **Explore any connections between gaps in TAO observations and spreads among ensemble ORAs**
- **Articulate needs for sustained and enhanced ocean observations for TPOS2020**
- **Monitor signal-to-noise ratio and climate signals associated with ENSO, Pacific Decadal Oscillation, Indian Ocean Dipole, Tropical Atlantic Variability**

Tropical Pacific Observing Systems

Black: All data
Red: TAO/TRITON
Blue: XBT
Green: Argo

2004-2011



Coordinated Observing System Experiments At NCEP and GFDL (2004-2011)

	CTL	ALL	noMoor	noArgo
In situ data included	no profiles	all profiles	all except moorings	all except Argo
XBT	×	√	√	√
TAO	×	√	×	√
Argo	×	√	√	×

- What are the mean biases and RMSE (monthly anomalies) in the control simulations when no in situ observations are assimilated?
- How well are mean biases and RMSE constrained by assimilation of all in situ observations?
- What are influences of withholding mooring or Argo data on mean biases and RMSE?

NCEP's Global Ocean Data Assimilation System

- **MOM4p1, 0.5° resolution, 1/4° in 10°S-10°N, 40 levels**
- **Daily fluxes from NCEP Reanalysis 2**
- **3D-VAR, Univariate in temperature and salinity (Behringer 2007)**
- **Horizonal covariance with scale elongated in zonal direction, vertical covariance as function of local vertical temperature gradient**
- **Temperature profiles and OISST assimilated**
- **Synthetic salinity derived with climatology T/S relationship and temperature profiles from XBT and moorings, observed salinity from Argo assimilated**
- **Altimetry SSH not assimilated**
- **Temperature (salinity) at 5m is relaxed to daily OISST (Levitus salinity climatology) with 10 (30) day relaxation time scales.**

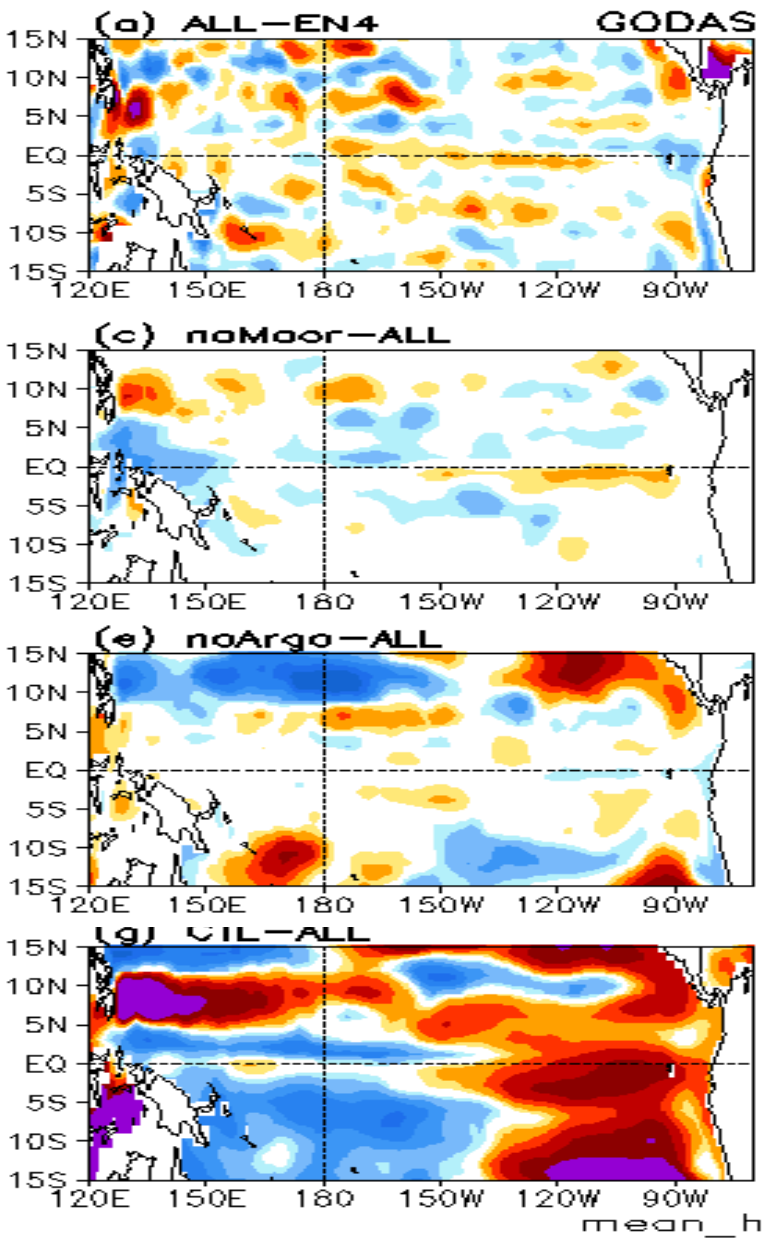
Evaluation of OSEs

- **Evaluation data**
  - **TAO temperature and current**
  - **Altimetry SSH from AVISO**
  - **Surface current from OSCAR**
  - **EN4 temperature and salinity analysis (objective analysis based on in situ data only) is used as reference but not the "truth"**

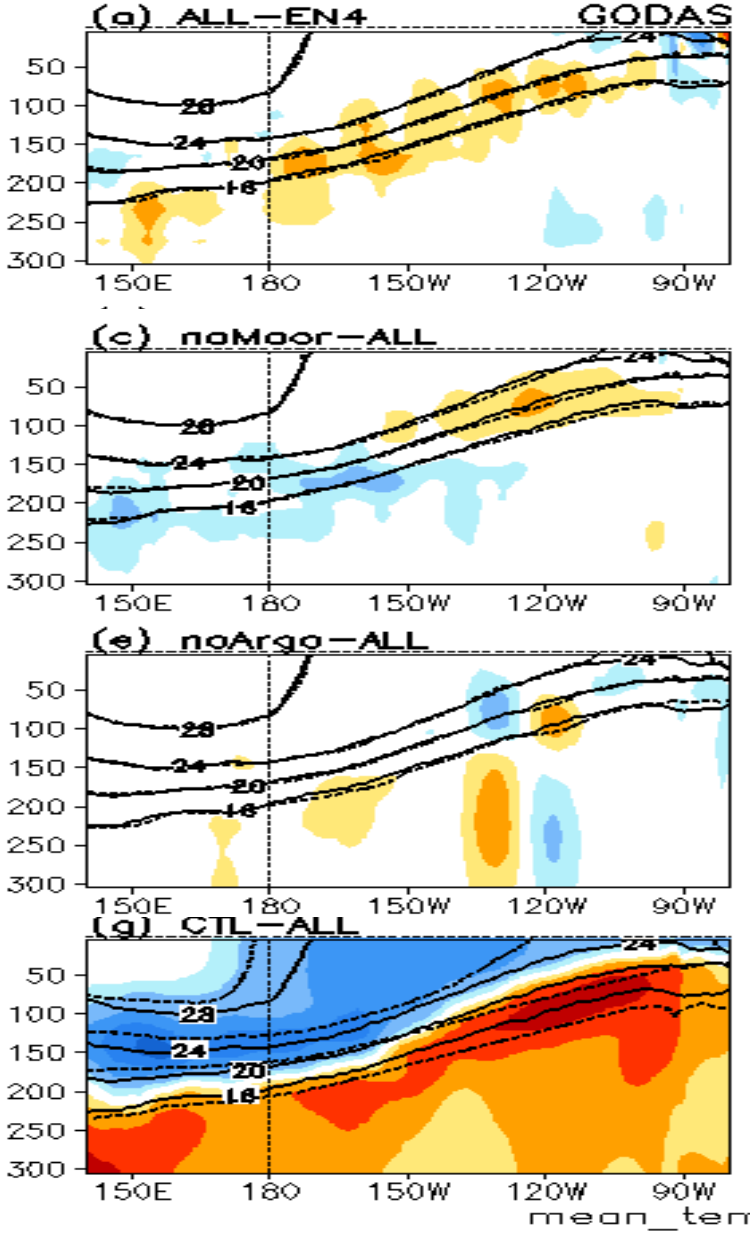
- **Evaluation Methods**
  - **Mean and annual cycle**
  - **Standard deviation (STD)**
  - **Root-mean-square error (RMSE) and anomaly correlation coefficient (ACC)**
  - **Integrated RMSE in upper 300m**

Mean Biases

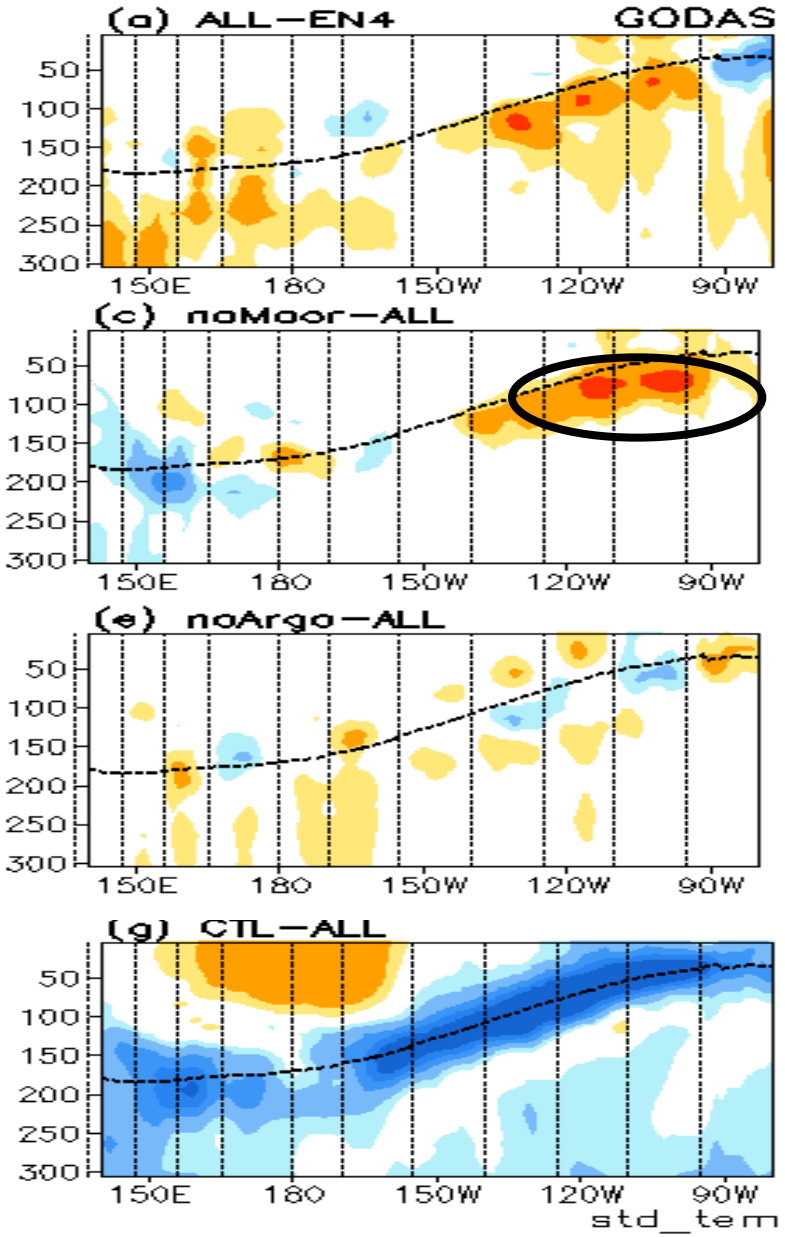
HC300

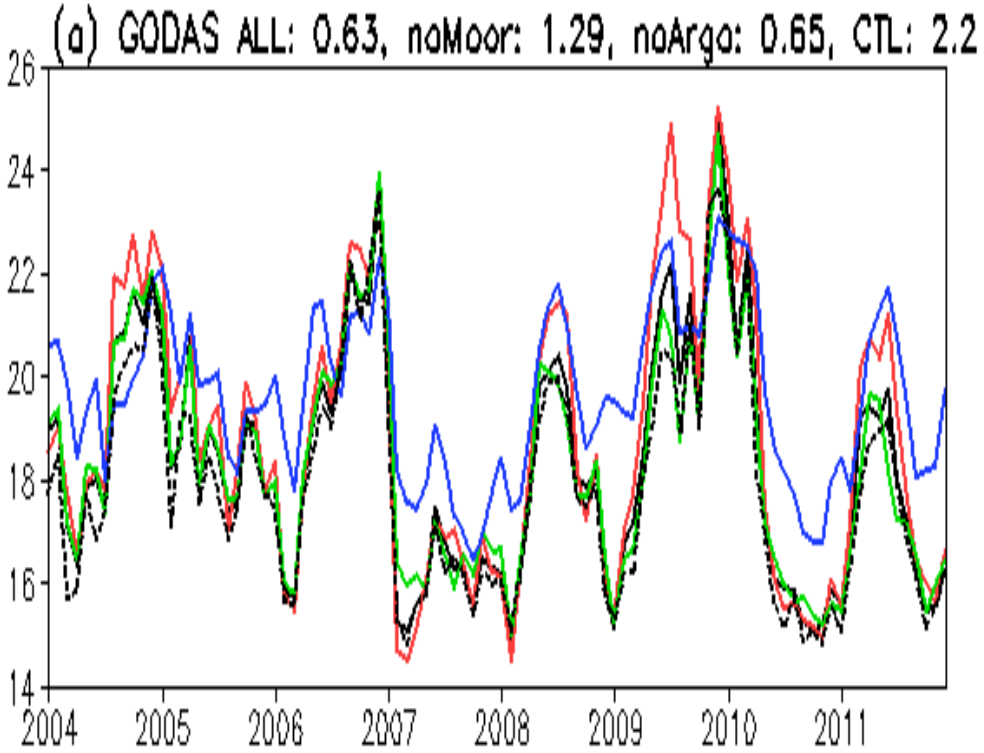


Temp at Eq



STD Biases near Eq

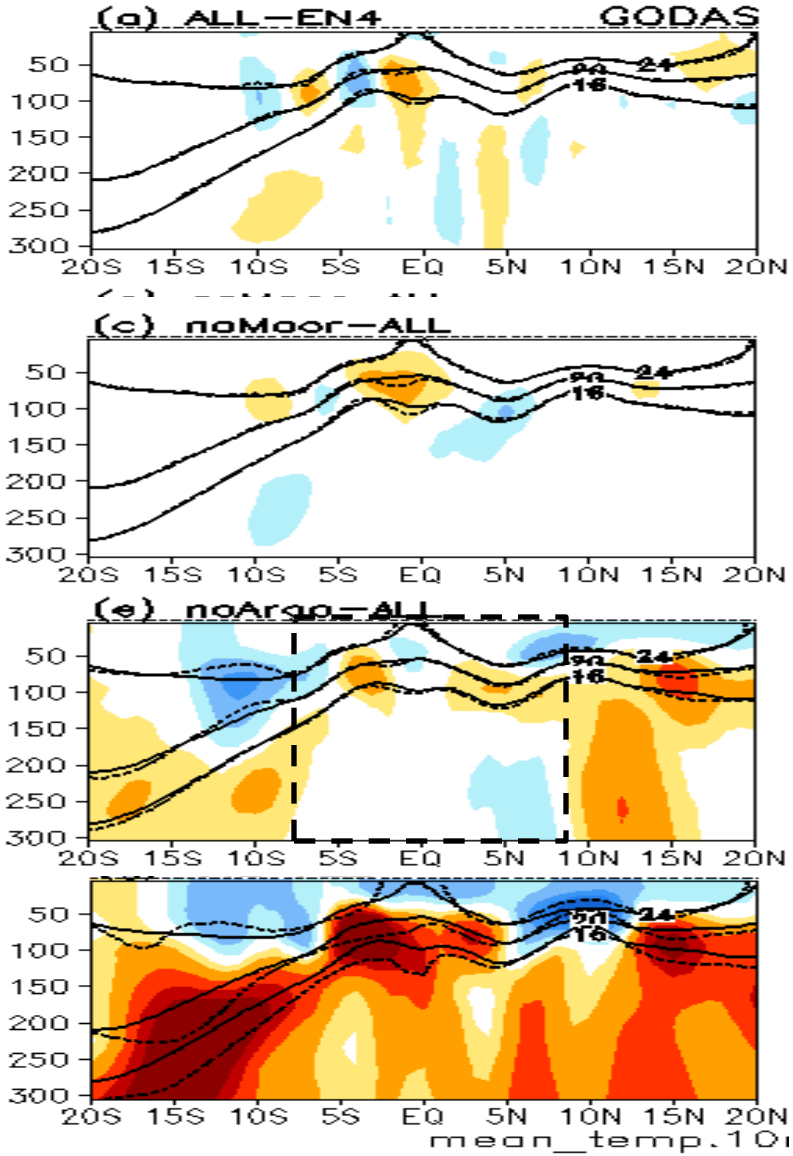




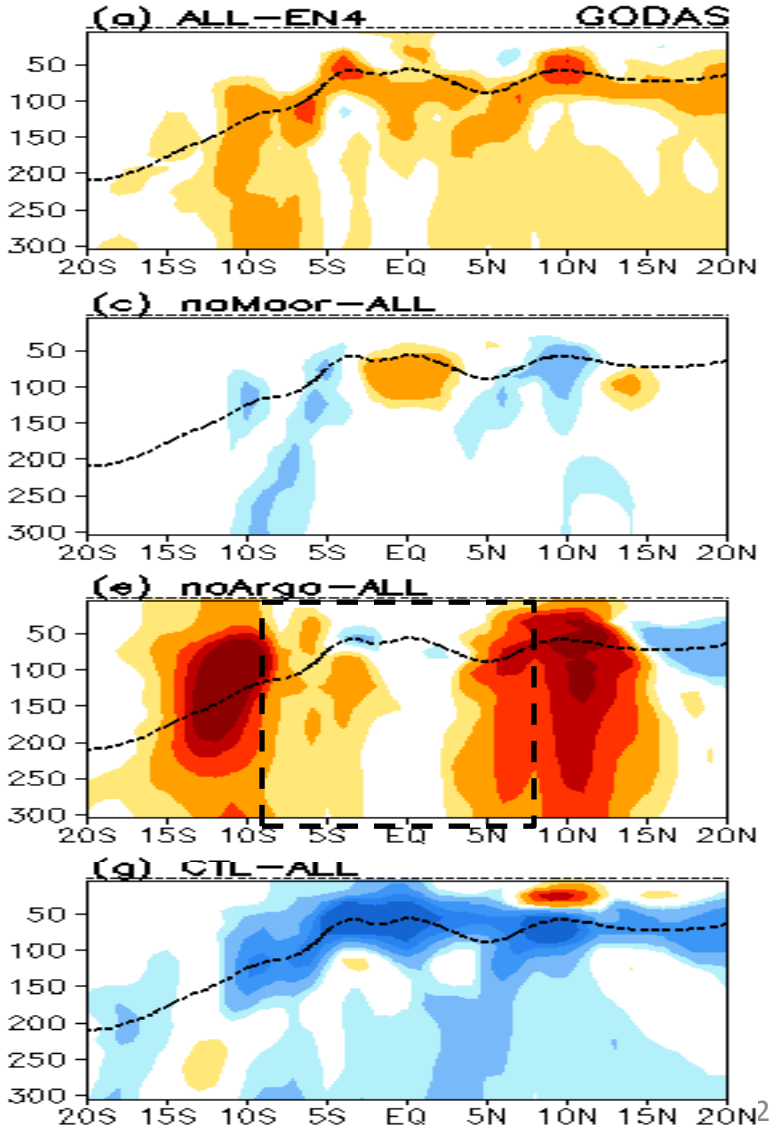
TAO (dotted line)
ALL
noMoor
noArgo
CTL

130°W-100°W

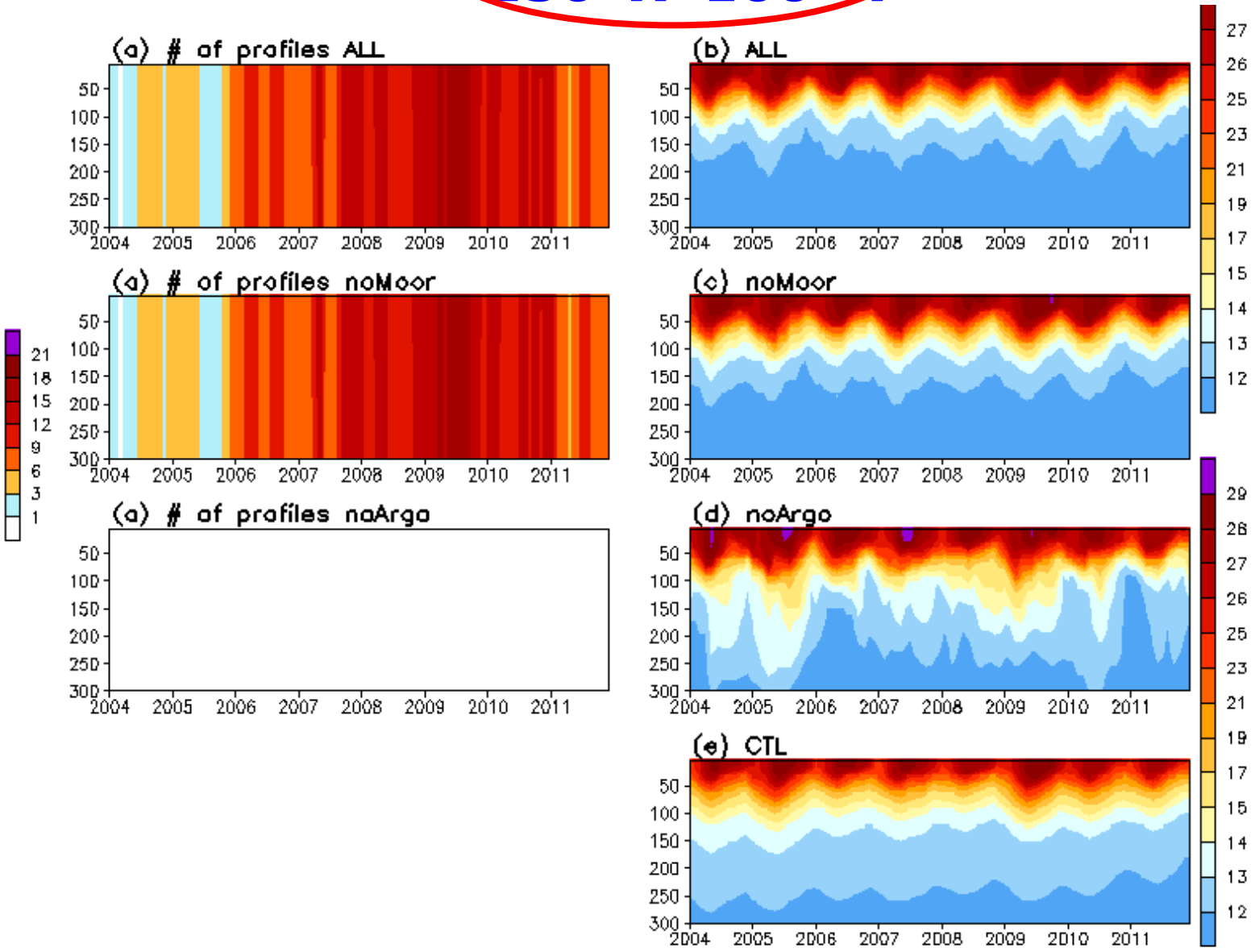
Mean Biases



STD Biases

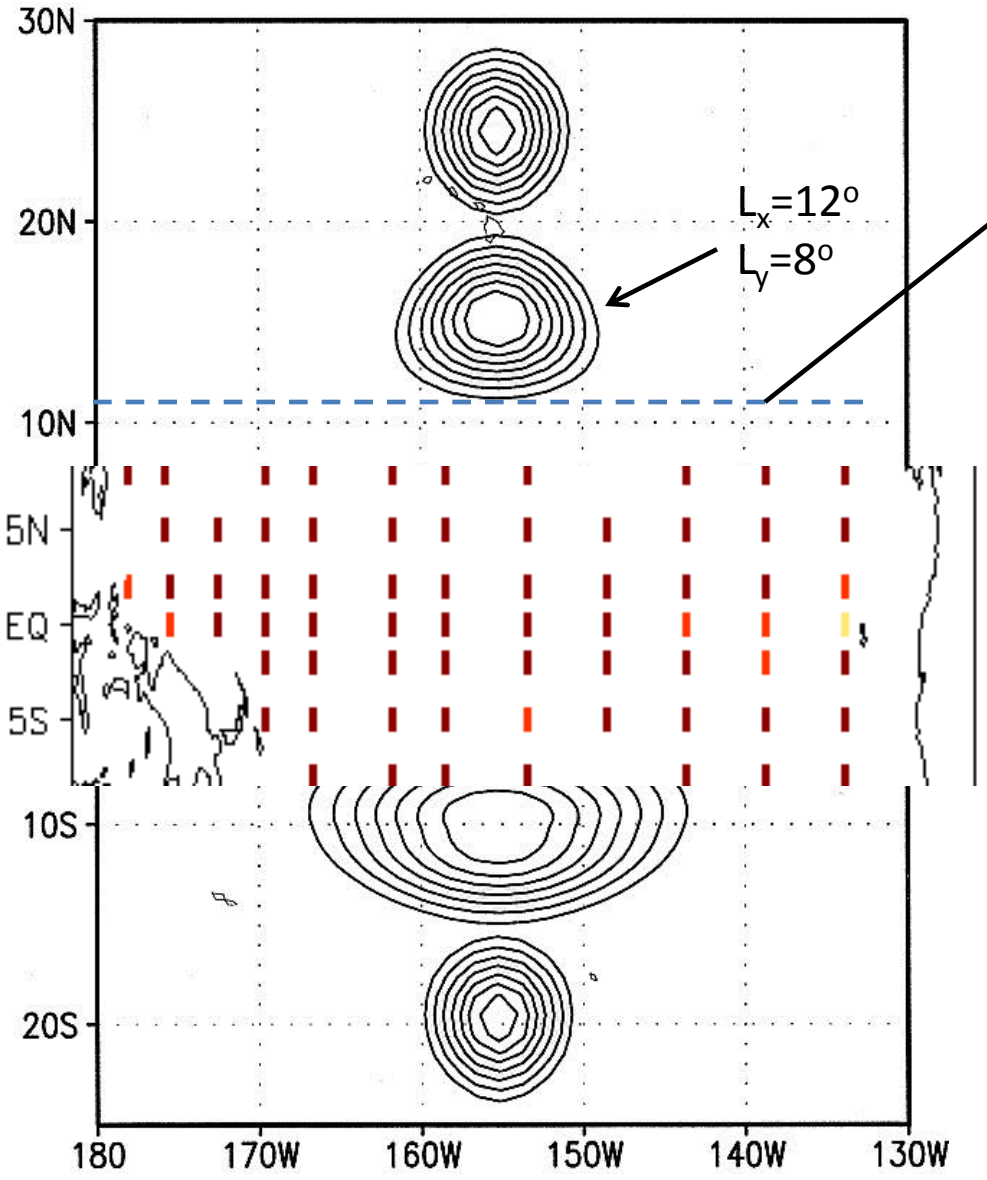


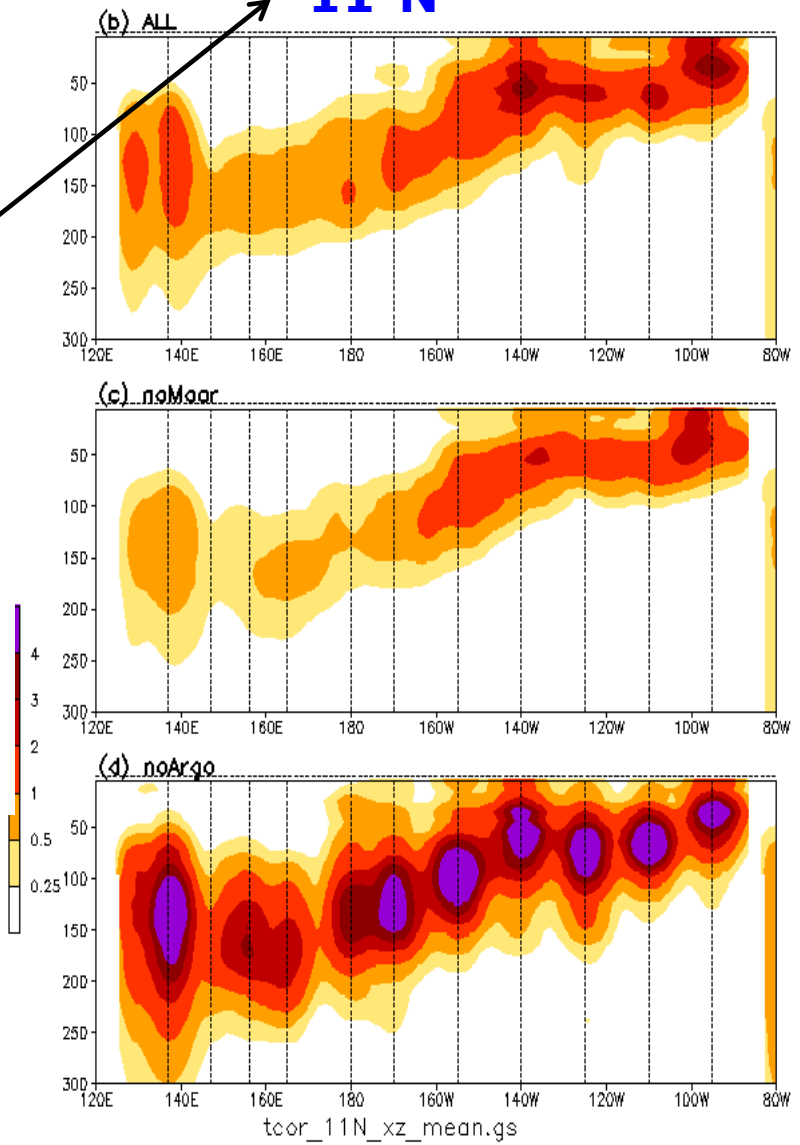
11°N-12°N, 130°W-100°W



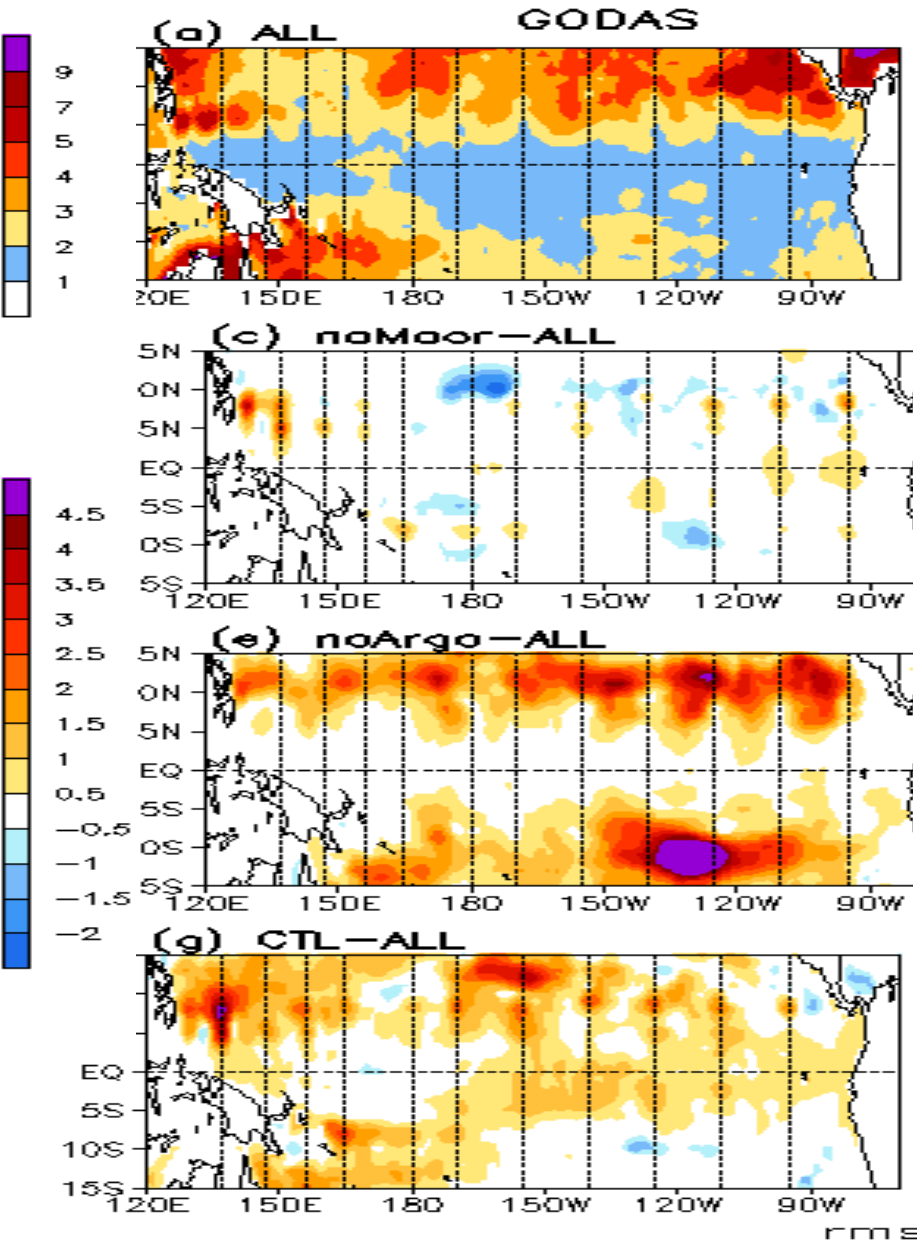
temp_11N-12N_130W-100W_zt.gs

Variance of Temp. Increment 11ºN

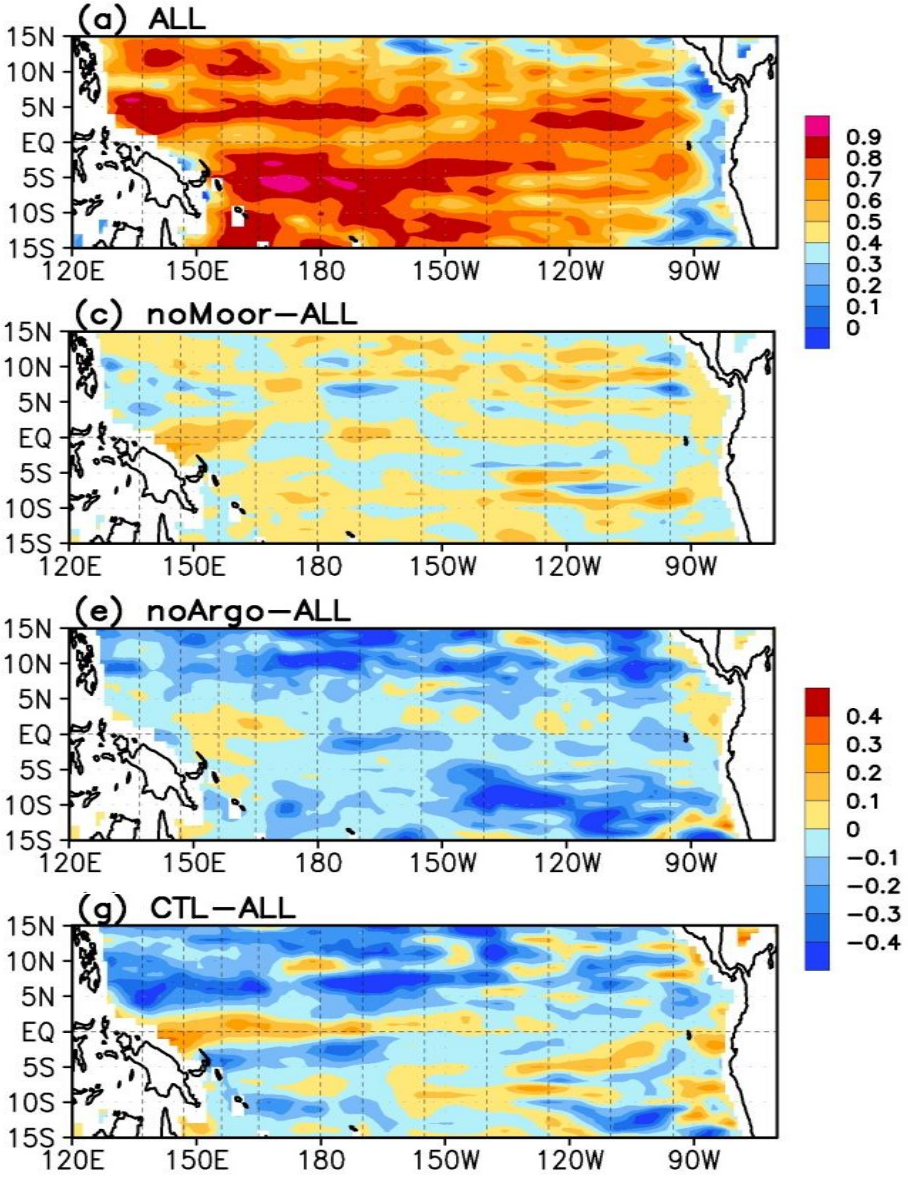




RMSE with Altimetry SSH

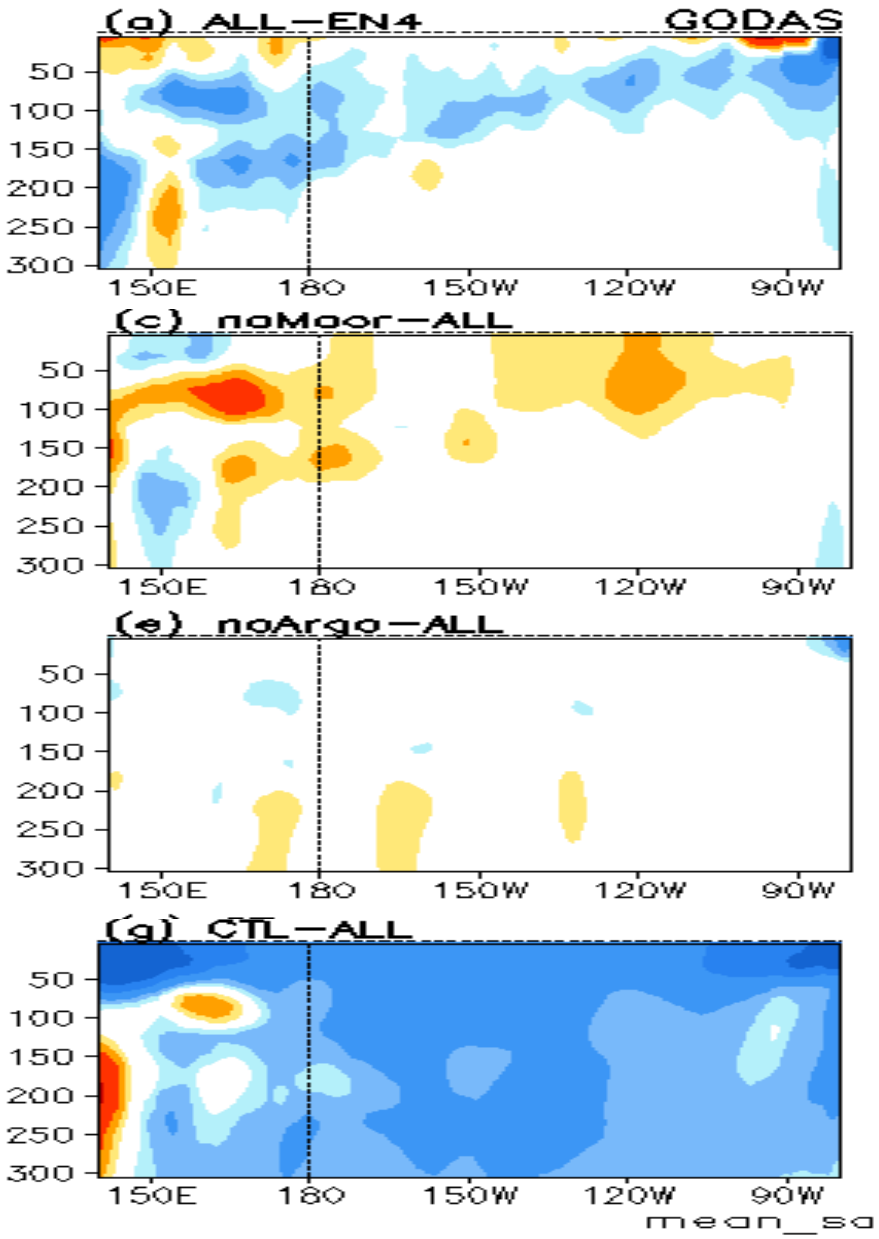


Correlation with OSCAR U

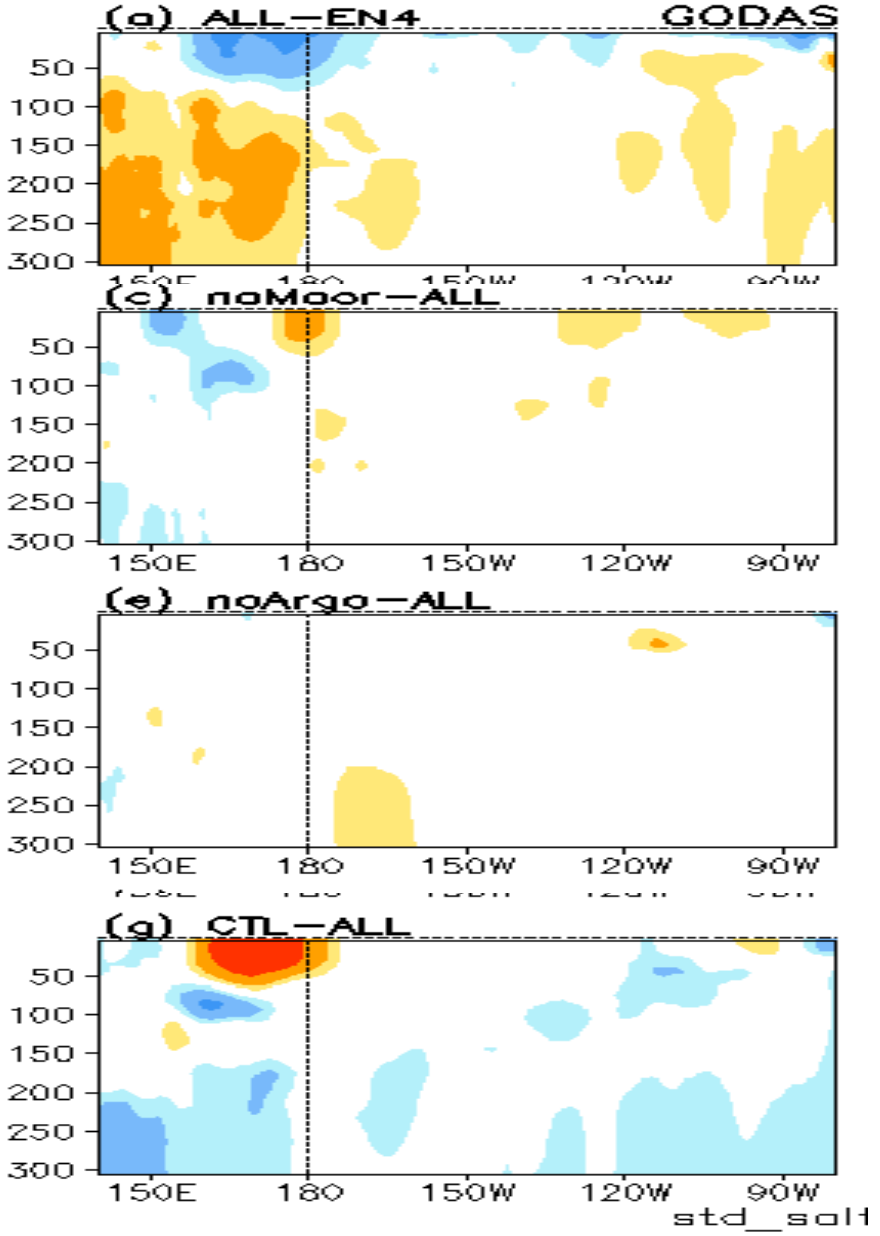


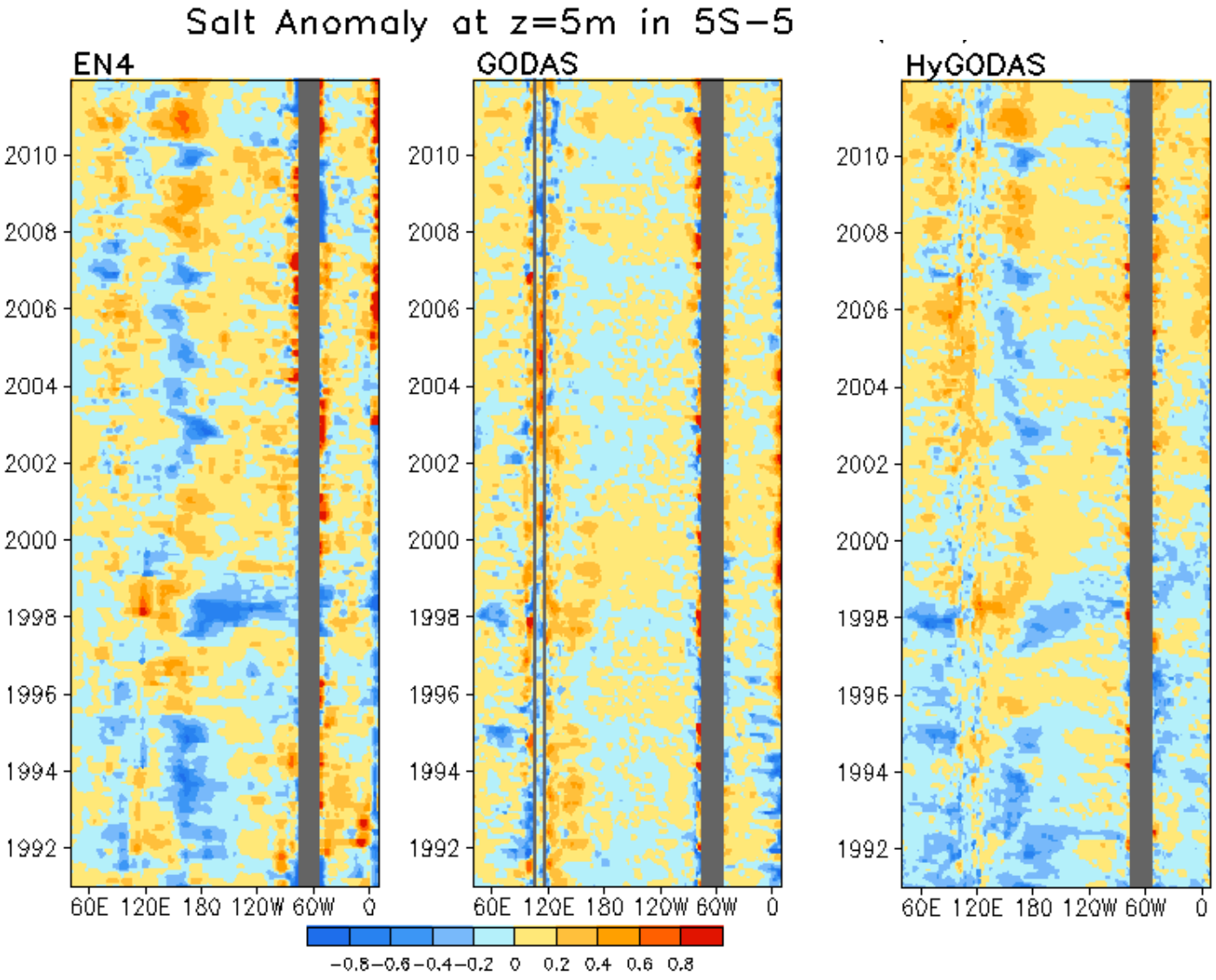
Salinity

Mean Biases



STD Biases



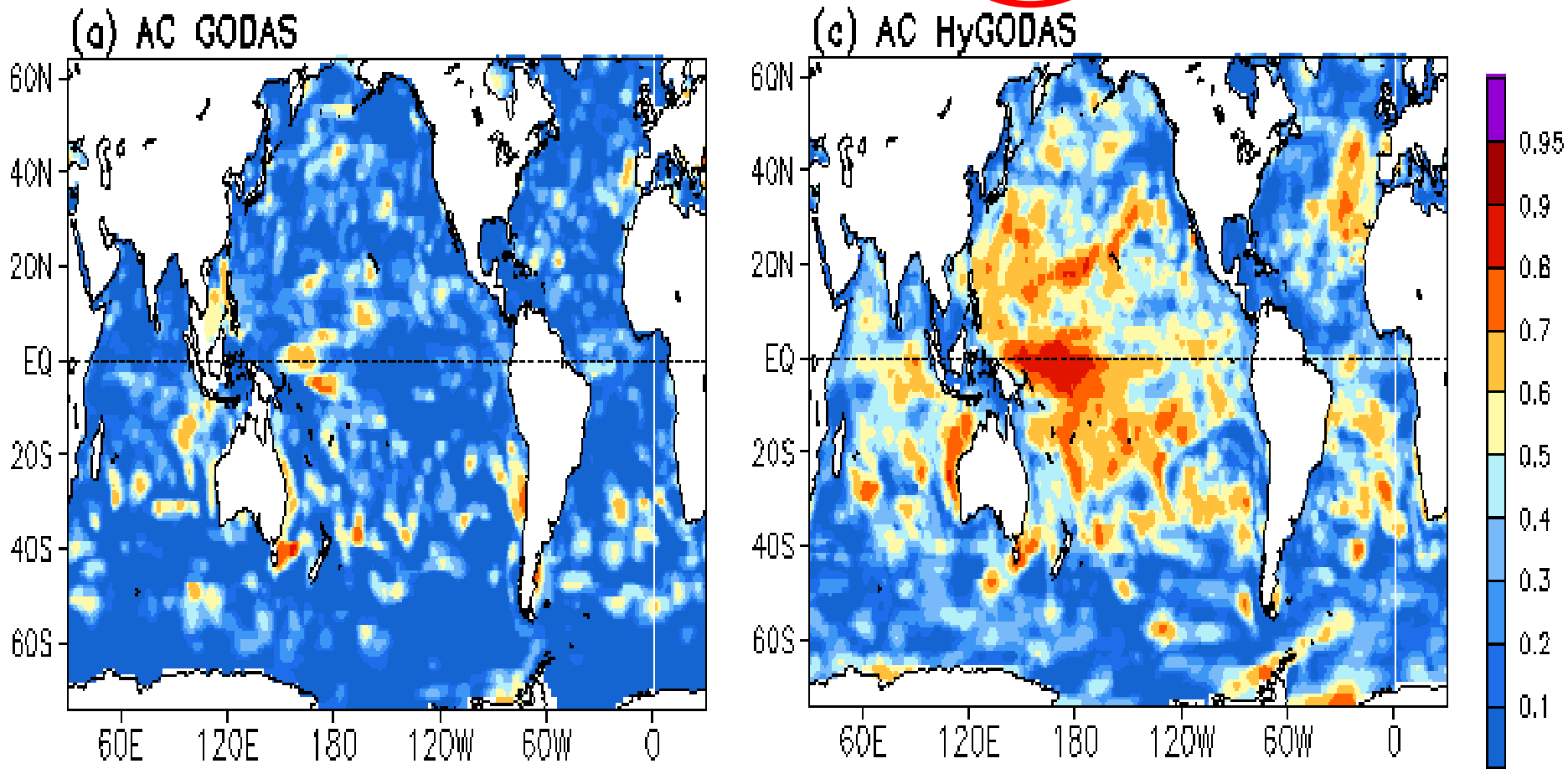


- **SSS anomaly associated ENSO was well simulated by HyGODAS.**

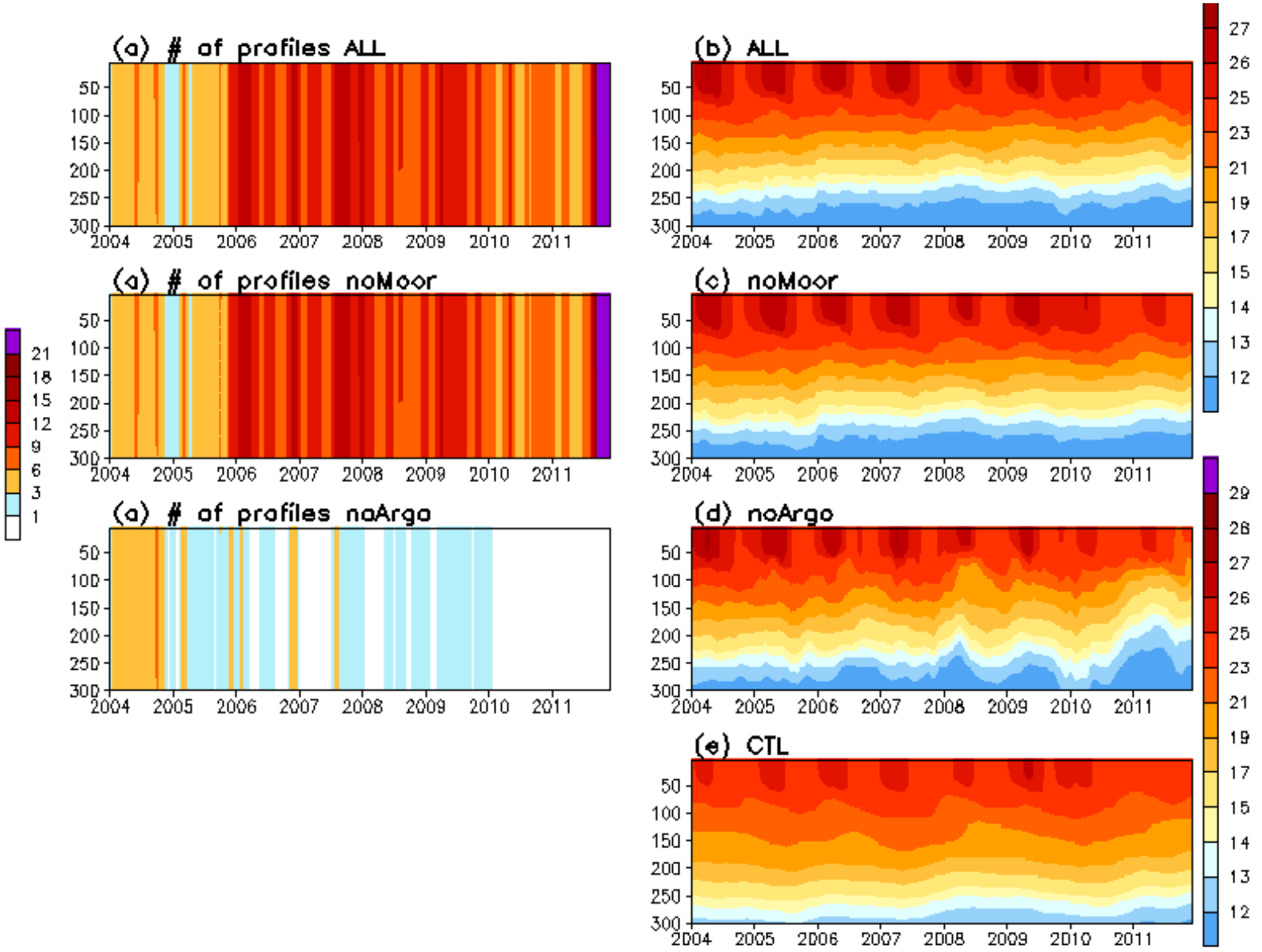
Summary

- **Observing System Experiments (OSEs) were used to evaluate relative impacts of TAO/TRITON and Argo data on NCEP GODAS ocean reanalysis in 2004-2011.**
- **Without assimilation of any in situ data, GODAS had large mean biases, STD biases and RMSE.**
- **Assimilation of in situ data significantly reduced mean biases, STD biases and RMSE in all variables except zonal current at equator.**
- **For constraining temperature analysis, the TAO/TRITON data is more critical than the Argo data in the equatorial Pacific, but the Argo data is more important in off-equatorial regions.**
- **For constraining salinity, sea surface height and surface current analysis, the influence of Argo data is more critical.**
- **The OSE simulations reveal several drawbacks in GODAS: 1) Without Argo data GODAS had erroneous variability in 8N-14N and 8S-15S probably due to too strong fitting to nearby TAO and sparse XBT data ; 2) salinity variability is too damped due to assimilation of synthetic salinity.**

Comparison with EN4 Salt at 5m (SSS) 1995–2011



- **SSS was improved from GODAS to HyGODAS, particularly in the tropical Pacific.**



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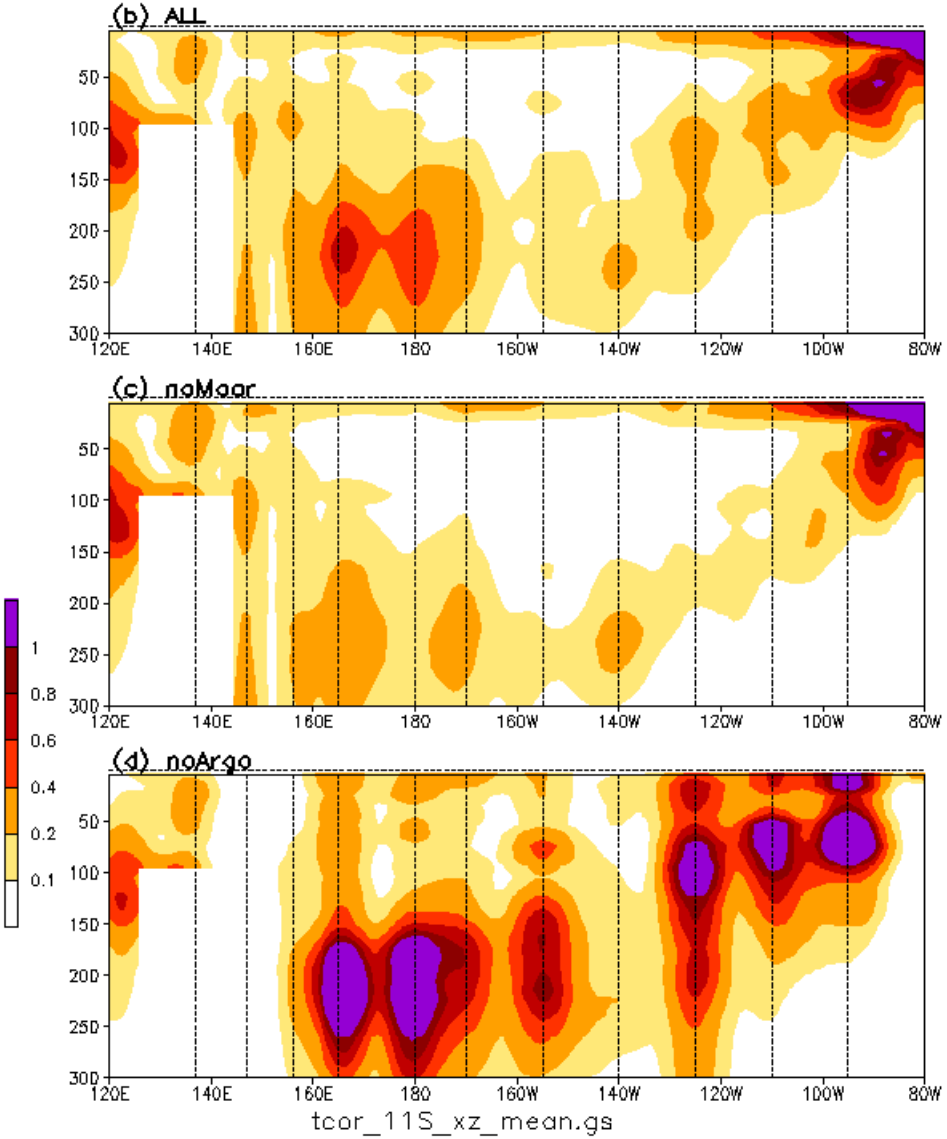
(b) ALL
(c) noMoor
(d) noArgo
50
100
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140E
160E
180
160W
140W
120W
100W
80W
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0.4
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tcor_11S_xz_mean.gs